

Alaska Department of Environmental Conservation
410 Willoughby Avenue, Suite 303
P.O. Box 111800
Juneau, Alaska 99801

**Total Maximum Daily Load (TMDL)
for Fecal Coliform in the Waters of
Pederson Hill Creek in Juneau, Alaska**

May 2007

Contents

Executive Summary	1
1. Overview	4
1.1. Watershed Location and Characteristics	4
1.2. Land Use.....	5
1.3. Climate.....	7
2. Water Quality Standards and TMDL Target.....	8
2.1. Applicable Water Quality Standards	8
2.2. Designated Use Impacts	8
2.3. TMDL Target	8
3. Data Inventory and Analysis	10
4. Pollutant Sources.....	14
4.1. Point Sources	14
4.2. Nonpoint and Natural Sources.....	14
5. Analytical Approach	16
5.1. Load Duration Curves	16
5.2. Stream Flow Estimates	17
5.3. Existing Loads and Loading Capacity.....	21
6. TMDL	22
6.1. Margin of Safety	22
6.2. Load Allocation	23
6.3. Wasteload Allocation	23
6.4. Critical Conditions and Seasonal Variation.....	23
6.5. Daily Loads.....	23
7. Implementation.....	24
8. Monitoring.....	27
9. Public Comments	28
10. References.....	29

Figures

Figure 1-1. Location of Pederson Hill Creek watershed (source: topozone.com)	5
Figure 1-2. Pederson Hill Creek watershed	6
Figure 1-3. Monthly average precipitation and temperatures at Juneau International Airport	7
Figure 3-1. Fecal coliform data for Pederson Hill Creek	13
Figure 5-1. Location of USGS gages in proximity to Pederson Hill Creek	18
Figure 5-2. Lemon Creek (15052000) flows versus Montana Creek (15052800) flows.	19
Figure 5-3. Salmon Creek (15051010) flows versus Montana Creek (15052800) flows.	19
Figure 5-4. Gold Creek (15049900) flows versus Montana Creek (15052800) flows.....	20
Figure 5-5. Time series of overlapping Montana Creek and Salmon Creek flows.	20
Figure 5-6. Estimated existing fecal coliform loads and loading capacity for Pederson Hill Creek.	21
Figure 8-1. Proposed sites for ADEC sampling in May–June 2007.	27

Tables

Table 2-1. Alaska water quality standards for fecal coliform	9
Table 3-1. Locations sampled under ACWA grants 05-12 and 06-11 ¹	11
Table 3-2. Summary of available fecal coliform data for Pederson Hill Creek	12
Table 5-1. USGS gages located in proximity to Pederson Hill Creek	18
Table 5-2. Summary of fecal coliform load duration analysis in Pederson Hill Creek	21
Table 6-1. TMDL allocations for fecal coliform in Pederson Hill Creek	22
Table 7-1. Fecal coliform removal for various BMPs	25
Table 7-2. Applicability of BMPs to cold climate conditions (CWP, 1997)	25

Total Maximum Daily Load for Fecal Coliform in the Waters of Pederson Hill Creek in Juneau, Alaska

TMDL AT A GLANCE:

<i>Water Quality-limited?</i>	Yes
<i>Hydrologic Unit Code:</i>	19010301
<i>Criteria of Concern:</i>	Fecal coliform
<i>Designated Uses Affected:</i>	Water supply and water recreation
<i>Major Source(s):</i>	Septic systems

	High Flows (0-10 percentile)	Moist Conditions (10-40 percentile)	Mid-range Flows (40-60 percentile)	Dry Conditions (60-90 percentile)	Low Flows (90-100 percentile)
<i>Loading Capacity:</i>	26,874	10,988	6,464	3,555	1,777
<i>Load Allocation:</i>	24,187	9,889	5,817	3,199	1,599
<i>Wasteload Allocation:</i>	n/a	n/a	n/a	n/a	n/a
<i>Margin of Safety (10%):</i>	2,687	1,099	646	355	178
<i>Load Reduction (%):</i>	98%	65%	35%	76%	90%

Executive Summary

Pederson Hill Creek (also known as Casa Del Sol Creek) is located in the Mendenhall Valley approximately 10 miles northwest of downtown Juneau in southeast Alaska. The state of Alaska included Pederson Hill Creek on its 2006 303(d) list as water quality-limited due to fecal coliform with septic tanks listed as the expected pollutant source. A Total Maximum Daily Load (TMDL) is established in this document to meet the requirements of Section 303(d)(1)(C) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR Part 130), which require the establishment of a TMDL for the achievement of water quality standards when a waterbody is water quality-limited. A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background loads. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. A TMDL represents the amount of a pollutant the waterbody can assimilate while maintaining compliance with applicable water quality standards.

Applicable water quality standards for fecal coliform in Pederson Hill Creek establish water quality criteria for the protection of designated uses for water supply, water recreation, and growth and propagation of fish, shellfish, other aquatic life, and wildlife. The TMDL is developed for the most

stringent of these—the fecal coliform criteria for drinking, culinary, and food processing water supply that state that in a 30-day period, the geometric mean may not exceed 20 FC/100 mL, and not more than 10 percent of the samples may exceed 40 FC/100 mL (18 AAC 70 (1)(A)(i)).

The TMDL for Pederson Hill Creek is based on the load duration approach to identify allowable loads as well as estimate existing loads and necessary load reductions. The load duration curve approach involves calculating the allowable loadings of a pollutant over the range of flow conditions expected to occur in the impaired stream. The flows displayed on a load duration curve may be grouped into various flow regimes to aid with interpretation of the load duration curves, including the following five “hydrologic zones” (Cleland, 2002, 2003):

- High flow zone: stream flows that plot in the 0 to 10-percentile range, related to flood flows
- Moist zone: flows in the 10 to 40-percentile range, related to wet weather conditions
- Mid-range zone: flows in the 40 to 50 percentile range, median stream flow conditions
- Dry zone: flows in the 60 to 90-percentile range, related to dry weather flows
- Low flow zone: flows in the 90 to 100-percentile range, related to drought conditions

Because Pederson Hill Creek does not have a continuous flow record or a dataset of flows covering a broad range of flow conditions during times of water quality sampling, flow was estimated for the creek based on nearby USGS gages draining creeks with similar watershed characteristics. The estimated flow record was then used with the not-to-exceed water quality criterion of 40 FC/100 mL to develop the curve of allowable daily loads. Because the analysis is based on calculation of individual allowable loads corresponding to discrete streamflow values, it is most appropriate to use the not-to-exceed criterion, which represents an instantaneous measurement of bacteria levels in the water column. It is assumed that use of the not-to-exceed criterion as a daily maximum target in Pederson Hill Creek will also meet the geometric mean criterion of 20 FC/100 mL. The flow record was also used with observed fecal coliform data to calculate “existing” daily loads. Figure ES-1 presents the load duration curve and calculated existing loads.

Table ES-1 summarizes the results of the TMDL analysis, providing allocations for each of the five hydrologic zones. The MOS was included explicitly as 10 percent of the loading capacity. Because there are no point sources in the Pederson Hill Creek watershed, the remainder of the loading capacity is assigned to the load allocation for nonpoint sources.

Extension of the City and Borough of Juneau’s public sewer system will eliminate the use of septic systems in a portion of the Pederson Hill Creek watershed. Because failing septic systems are expected to be a source of bacteria, the sewer extension will help to reduce bacteria loading to the creek. In addition, continued education of area homeowners on the importance of the proper operation and maintenance of their onsite septic systems is recommended to further control bacteria loading to the creek. Future monitoring will focus on better characterizing the potential sources of fecal coliform, including septic systems and horse stables in the watershed, and future implementation efforts will be developed accordingly.

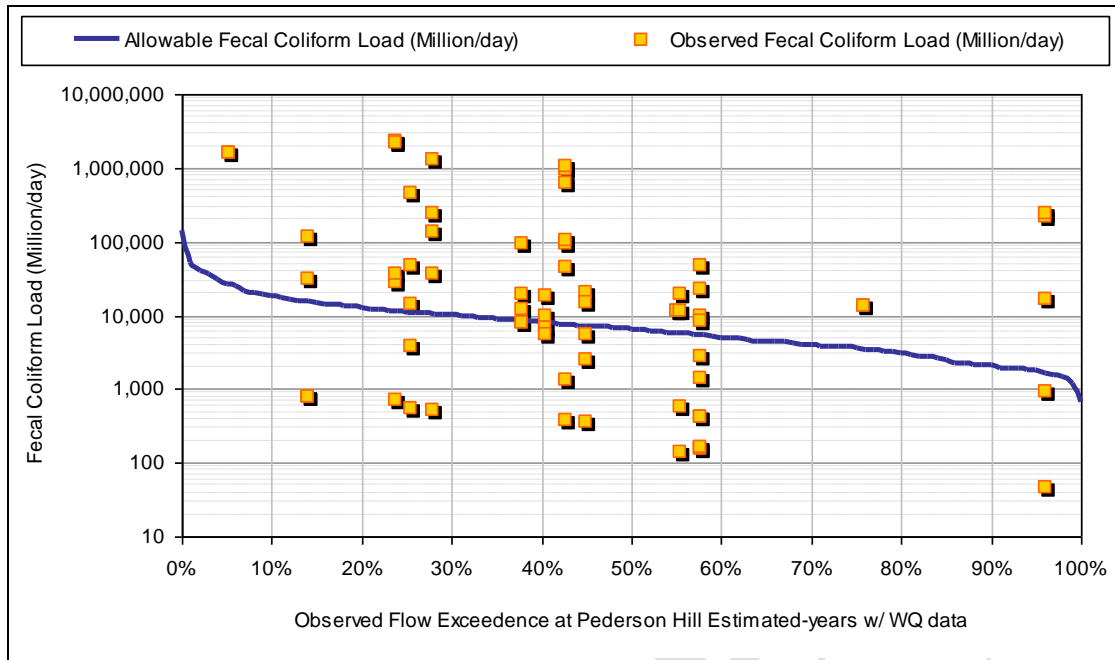


Figure ES-1. Estimated existing fecal coliform loads and loading capacity for Pederson Hill Creek.

Table ES-1. TMDL allocations for fecal coliform in Pederson Hill Creek

Fecal Coliform (Million/day)	TMDL Component	High Flows	Moist Conditions	Mid-range Flows	Dry Conditions	Low Flows
		0-10	10-40	40-60	60-90	90-100
	Current Load ¹	1,599,742	27,881	8,917	13,331	16,241
	TMDL= LA+WLA+MOS	26,874	10,988	6,464	3,555	1,777
	LA	24,187	9,889	5,817	3,199	1,599
	WLA	n/a	n/a	n/a	n/a	n/a
	MOS (10%)	2,687	1,099	646	355	178
	TMDL Reduction (%)	98%	65%	35%	76%	90%

¹Current load represents median existing load for the respective flow zone. TMDL represents median allowable daily load for the respective flow zone.

1. Overview

Section 303(d)(1)(C) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR Part 130) require the establishment of a Total Maximum Daily Load (TMDL) for the achievement of state water quality standards when a waterbody is water quality-limited. A TMDL identifies the amount of pollution control needed to maintain compliance with standards and includes an appropriate margin of safety. The focus of the TMDL is reduction of pollutant inputs to a level (or "load") that fully supports the designated uses of a given waterbody. The mechanisms used to address water quality problems after the TMDL is developed can include a combination of best management practices (BMPs) and/or effluent limits and monitoring required through National Pollutant Discharge Elimination System permits.

The state of Alaska included Pederson Hill Creek on its 2004 303(d) list as water quality-limited due to fecal coliform with septic tanks listed as the expected pollutant source. The creek (Alaska ID Number 10301-014) was originally listed in 1990 for non-attainment of the fecal coliform bacteria standard from certain areas of failing on-site septic systems.

This report documents the TMDL developed for fecal coliform in Pederson Hill Creek. The following sections provide general background information on the Pederson Hill Creek watershed.

1.1. Watershed Location and Characteristics¹

Pederson Hill Creek (also known as Casa Del Sol Creek) is located in the Mendenhall Valley approximately 10 miles northwest of downtown Juneau (Figure 1-1). The total length of Pederson Hill Creek is 2 miles, including an approximately 1-mile intertidal section. The creek drains more than 1,000 acres from both Pederson Hill on the Mendenhall Peninsula and an unnamed ridge separating the Mendenhall and Auke drainages. Pederson Hill Creek runs through wetlands, collecting a number of small side valley tributaries, until its confluence with the Mendenhall River in the estuary near the south end of Mendenhall Peninsula in the Mendenhall Wetlands State Game Refuge. Side tributaries start as relatively high gradient, bedrock contained primary channels that are influenced primarily by surface and subsurface flow. These source streams are ephemeral and respond to rainfall and snowmelt events. Drainage ditches along road systems contribute surface flow from sheeting flow which empty into tributary streams.

Watershed soils are generally bedrock, fractured rock and cobble in primary streams, changing to gravels and mixed gravel/cobble in secondary stream reaches which tend to be associated with climax or secondary forest (mixed spruce/hemlock) habitats. In the meadows and wetlands, soils are generally glacial silts, marine silts and clays, and mixed gravel.

¹ Information in this section is summarized from Alaska Department of Environmental Conservation's (ADEC's) waterbody assessment for Pederson Hill Creek (ADEC, undated) and a project report for the Mendenhall Watershed Partnership (MWP) Alaska Clean Water Action (ACWA) grant ACWA 05-12 (MWP, undated).



Figure 1-1. Location of Pederson Hill Creek watershed (source: topozone.com)

1.2. Land Use

The intertidal portion of Pederson Hill Creek runs through wetlands while areas along upper reaches of tributaries and the mainstem have been developed for residential and commercial uses (Figure 1-2). MWP (undated) identifies the following major land use areas:

- The area around North Glacier Highway drains through several residential subdivisions and includes some commercial uses, including a church and horse corral and stables.
- The area around the intersection of South Glacier Highway and Engineers Cutoff drains through residential structures and mixed industrial (heavy equipment maintenance and storage) and commercial uses, including a medical clinic and office buildings.
- The area around Engineers Cutoff drains primarily residential properties, although some remnant commercial/industrial uses are still present on estuary/meadow habitats.
- The middle section of the watershed drains flat meadows with some residential and industrial uses including parking lots, the local Fire Training Center, a commercial horse farm and stable, and a golf course.



Figure 1-2. Pederson Hill Creek watershed

1.3. Climate

The Juneau area is contained in the “maritime” climate zone of Alaska. The maritime climate zone includes the Southeast, the Northern Gulf Coast and the Aleutian Chain areas of the state. In these areas the temperatures are milder than other zones, with the summer to winter range of average temperatures from near 60 degrees Fahrenheit (°F) to the 20s (WWRC, 2002). In the maritime zone a coastal mountain range coupled with plentiful moisture produces annual precipitation amounts up to 200 inches in the southeastern panhandle, and up to 150 inches along the northern coast of the Gulf of Alaska. Amounts decrease to near 60 inches on the southern side of the Alaska Range in the Alaska Peninsula and Aleutian Island sections. Figure 1-3 presents a summary of monthly averages for rainfall, snowfall and temperature at the Juneau International Airport (504100), based on the period of record at the station from September 1949 to October 2006.

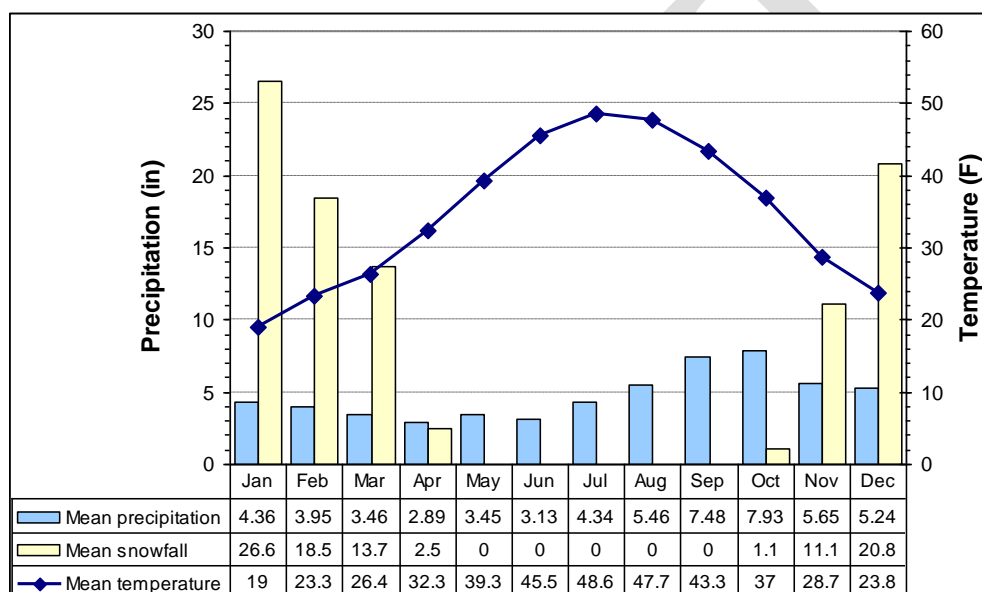


Figure 1-3. Monthly average precipitation and temperatures at Juneau International Airport

2. Water Quality Standards and TMDL Target

Water quality standards designate the “uses” to be protected (e.g., water supply, recreation, aquatic life) and the “criteria” for their protection (e.g., how much of a pollutant can be present in a waterbody without impairing its designated uses). TMDLs are developed to meet applicable water quality standards, which may be expressed as numeric water quality criteria or narrative criteria for the support of designated uses. The TMDL target identifies the numeric goals or endpoints for the TMDL that equate to attainment of the water quality standards. The TMDL target may be equivalent to a numeric water quality standard where one exists, or it may represent a quantitative interpretation of a narrative standard. This section reviews the applicable water quality standards and identifies an appropriate TMDL target for calculation of the fecal coliform TMDL in Pederson Hill Creek.

2.1. Applicable Water Quality Standards

Title 18, Chapter 70 of the Alaska Administrative Code (ACC) establishes water quality standards for the waters of Alaska, including the designated uses to be protected and the water quality criteria necessary to protect the uses. Designated uses established in the State of Alaska Water Quality Standards (18 AAC 70) for fresh waters of the state include (1) water supply, (2) water recreation, and (3) growth and propagation of fish, shellfish, other aquatic life, and wildlife, and are applicable to all fresh waters, unless specifically exempted. Fecal coliform water quality standards for each use and applicable to Pederson Hill Creek are presented in Table 2-1. The TMDL must be developed to meet all applicable criteria. The most stringent of these is the following criteria for drinking, culinary, and food processing water supply:

In a 30-day period, the geometric mean may not exceed 20 FC/100 mL, and not more than 10% of the samples may exceed 40 FC/100 mL. (18 AAC 70 (1)(A)(i))

2.2. Designated Use Impacts

Designated uses for Alaska’s waters are established by regulation and are specified in the State of Alaska Water Quality Standards (18 AAC 70). For fresh waters of the state, these designated uses include (1) water supply, (2) water recreation, and (3) growth and propagation of fish, shellfish, other aquatic life, and wildlife. Pederson Hill Creek does not support its designated uses of water supply and water recreation due to elevated instream fecal coliform levels. The presence of fecal coliform indicates an increased risk of pathogen contamination in a waterbody. Consumption of or contact with pathogen-contaminated waters can result in a variety of gastrointestinal, respiratory, eye, ear, nose, throat and skin diseases.

According to ADEC’s waterbody assessment (ADEC, 1993), there is little documentation of public recreational uses of Pederson Hill Creek. The wetlands are used by waterfowl hunters and potential uses include fishing or wildlife watching. While Pederson Hill Creek is not a major fish producing stream, it provides good habitat for salmon fry from other local streams. Because the upper sections of Pederson Hill Creek are generally less than 5 feet wide, it is likely that those fishing in the stream do so from the banks and not while wading in the stream.

2.3. TMDL Target

The TMDL target is the numeric endpoint used to evaluate the loading capacity and necessary load reductions and represents attainment of applicable water quality standards. Pederson Hill Creek has applicable numeric water quality criteria for fecal coliform for each designated use, and the TMDL will be developed to meet the most stringent of these criteria—criteria for drinking, culinary, and food

processing water supply (water supply). By meeting the criteria for water supply, Pederson Hill Creek will also meet the criteria for all other uses. The water quality criterion of a not-to-exceed value of 40 FC/100 mL in a 30-day period will be used as the basis for this TMDL. Because the analysis is based on calculation of individual allowable loads corresponding to discrete streamflow values, it is most appropriate to use the not-to-exceed criterion, which represents an instantaneous measurement of bacteria levels in the water column. It is assumed that use of the not-to-exceed criterion as a daily maximum target in Pederson Hill Creek will also meet the geometric mean criterion of 20 FC/100 mL. Given the variability typically exhibited by bacteria levels, it is not likely that measurements will consistently be less than 40 FC/100 mL but greater than 20 FC/100 mL—resulting in attainment of the not-to-exceed target but also in a violation of the geometric mean criterion. For example, out of the 66 data points available in Pederson Hill Creek, only 6 samples measure between 20 and 40 FC/100 mL, meaning that 90 percent (60 of 66) of the data are either greater than or less than both criteria. If water quality data become available that show the geometric mean criterion is not being met, the TMDL can be revised.

Table 2-1. Alaska water quality standards for fecal coliform

Water Use	Description of Standard
(A) Water Supply	
(i) drinking, culinary and food processing	In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml. For groundwater, the FC concentration must be less than 1 FC/100 ml, using the fecal coliform Membrane Filter Technique, or less than 3 FC/100 ml, using the fecal coliform most probable number (MPN) technique.
(ii) agriculture, including irrigation and stock watering	The geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water supply, (1)(A)(i), apply.
(iii) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml. For products not normally cooked, the criteria for drinking water supply, (1)(A)(i), apply.
(iii) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
(B) Water Recreation	
(i) contact recreation	In a 30-day period, the geometric mean of samples may not exceed 100 FC/100 ml, and not more than one sample or more than 10% of the samples if there are more than 10 samples, may exceed 200 FC/100 ml.
(ii) secondary contact	In a 30-day period, the geometric mean of samples may not exceed 200 FC/100 ml, and not more than 10% of the total samples may exceed 400 FC/100 ml.
(C) Growth and Propagation of Fish, Shellfish, other Aquatic Life and Wildlife	Not applicable

3. Data Inventory and Analysis

The compilation and analysis of data and information is an essential step in understanding the general water quality conditions and trends in an impaired water. This section outlines and summarizes all of the data reviewed for Pederson Hill Creek. There have been a number of monitoring efforts for fecal coliform in Pederson Hill Creek; however, each monitoring project resulted in only a few samples collected over short time frames. The majority of the data are concentrated in the upper portion of the watershed. The following are the available sources of fecal coliform data for the creek:

- **Mendenhall Watershed Partnership (MWP)**—The MWP conducted monitoring on Pederson Hill Creek as part of two Alaska Clean Water Action (ACWA) grants to characterize water quality of the creek and develop a watershed assessment and management plan. The final project report for the Fiscal Year (FY) 2006 grant (ACWA-06-11) includes data collected at six sites (PHC-1 through PHC-6) during three sampling events—November 2005, February 2006 and May 2006. Under the FY05 grant, MWP collected data at seven sites during five sampling events from April through June of 2005. Because it is unclear whether the sites sampled under the two grants are in the same locations, sites for the FY05 grant are referred to as PHC-1a through PHC-7a and sites for the FY06 grant are referred to as PHC-1b through PHC-6b. Table 3-1 provides the descriptions of site locations as provided in grant reports, noting which FY05 and FY06 stations are thought to be co-located based on available grant documentation.
- **ADEC Juneau Streams Monitoring Project**—During 1991 and 1992, ADEC conducted three water quality sampling events at one site in Pederson Hill Creek as part of the Juneau Streams Monitoring Project. These data were obtained from Table 2 of ADEC's waterbody assessment and the station location is described as "the upper portion of the main stream mid-section."
- **Additional ADEC Monitoring**—ADEC conducted four fecal coliform monitoring events at nine sites on Pederson Hill Creek during May of 1994. The data are included in an August 24, 1995, memo from Dick Williams to Ursula Spannagel, attached to the waterbody assessment. The memo includes station location descriptions and a hand-drawn map indicating that the stations are located in the upper portion of the watershed in the area along Glacier Highway.
- **Septic System Compliance Monitoring**—As part of a compliance investigation, ADEC conducted sampling on October 4, 2005, at four sites in roadside ditches and runoff on residential properties on Engineers Cutoff Road. Because the data were not collected in the creek, they are not included in this section; however, they can be used generally to support the assumption that septic inputs are the primary source of bacteria impairment in the creek.

Table 3-2 summarizes the available fecal coliform data for Pederson Hill Creek and the Appendix includes a table of all data. The majority of data seems to be concentrated in the upstream, developed portions of the watershed, located above the tidal portion of the creek. Figure 3-1 presents all of the available fecal coliform data for Pederson Hill Creek. Because the data are limited and many of the station locations are unclear, it is difficult to do a confident analysis of temporal or spatial analysis. However, it is apparent that bacteria levels are highly variable and that the range of concentrations measured in recent years is comparable to those measured over the last decade.

Table 3-1. Locations sampled under ACWA grants 05-12 and 06-11¹

FY 05 Grant (05-12)		FY 06 Grant (06-11)	
Site	Description	Site	Description
PHC-1a	Above development	PHC-1b	Uphill of the Baptist church near the intersection of Glacier Highway and Engineers cutoff road. The area has dense brush and many areas of stagnant flow.
PHC-2a	North side of Glacier Highway	PHC-2b	Directly across Glacier Highway from the Baptist church is a small tributary that runs parallel to the highway and is fed by the water source for site #1 and other drainage. It runs under the highway through a culvert. This site represents water runoff from the drainage ditches on both sides of the highway.
PHC-3a	South side of Glacier Highway	PHC-3b	This sampling site was selected because of historically high measurements of fecal coliform bacteria in past studies. The source is primarily a residential development across Engineers Cutoff, runs under the road through a culvert. Accessible on the maintained nature trail in this area.
PHC-4a	Meadow site (staff gauge)	PHC-6b	This site is reached by driving to the end of Sherwood Lane. The road goes to gravel, and has a small turn around. A short walk through tall grass leads to a footbridge, the sampling site. This is the lowest point in the stream used for collection, and has higher flow levels than the upper sites.
PHC-5a	Engineers Cutoff (West Fork)		
PHC-6a	Above DMV culvert	PHC-5b	The east side of the fork described in PHC-4 was selected again due to historically high reports of fecal coliform bacteria. It contains the runoff from the parking lot and office buildings on Sherwood Lane.
PHC-7a	Below DMV culvert		
		PHC-4b	In between two office buildings, one housing the DMV, the other the USDA Forestry Sciences Laboratory, there is ready access to the stream on the edge of the parking lot. This site was chosen to test the tributary (the west fork in the stream), which emerges from an area of wetlands.

¹FY06 stations are listed in the same row as the FY05 station with which it is co-located. PHC-5a and PHC-7a are not co-located with any FY06 stations and PHC-4b is not co-located with a FY05 station.

Table 3-2. Summary of available fecal coliform data for Pederson Hill Creek

Station	Start Date	End Date	Number of Samples	Minimum	Average	Maximum	No. >40 FC/100mL	% >40 FC/100mL
<i>ADEC 1994 Sampling¹</i>								
ADEC-1	5/10/94	5/31/94	4	2	2.0	2	0	0%
ADEC-2	5/10/94	5/31/94	4	30	270.0	500	3	75%
ADEC-3	5/10/94	5/31/94	4	7	43.8	140	1	25%
ADEC-4	5/10/94	5/31/94	4	110	2,570.0	5,000	4	100%
ADEC-5	5/10/94	5/31/94	4	80	705.0	1,600	4	100%
ADEC-A	5/16/94	5/16/94	1	3,300	3,300.0	3,300	1	100%
ADEC-B	5/16/94	5/16/94	1	540	540.0	540	1	100%
ADEC-C	5/16/94	5/16/94	1	5,600	5,600.0	5,600	1	100%
ADEC-D	5/16/94	5/16/94	1	0	0	0	0	0%
<i>ADEC Juneau Streams Monitoring Project</i>								
JSM-1	2/11/91	9/5/92	3	80	876.7	2400	3	100%
<i>MWP FY05 Grant</i>								
PHC-1a	4/18/05	6/24/05	4	2	32.0	90	1	25%
PHC-2a	4/18/05	6/24/05	5	2	14.4	36.7	0	0%
PHC-3a	4/18/05	6/24/05	5	20	69.6	97.5	4	80%
PHC-4a	4/18/05	6/24/05	5	50	1844.6	8100	5	100%
PHC-5a	4/18/05	6/24/05	3	2	16.2	36.7	0	0%
PHC-6a	6/9/05	6/9/05	1	130	130.0	130	1	100%
PHC-7a	6/9/05	6/9/05	1	7600	7600.0	7600	1	100%
<i>MWP FY06 Grant</i>								
PHC-1b	11/5/05	2/20/06	2	1.1	1.1	1.1	0	0%
PHC-2b	11/5/05	11/5/05	1	1.1	1.1	1.1	0	0%
PHC-3b	11/5/05	5/15/06	3	22	89.3	164	2	67%
PHC-4b	11/5/05	5/15/06	3	4	1725.0	5100	2	67%
PHC-5b	11/5/05	5/15/06	3	1	1967.4	5900	1	33%
PHC-6b	11/5/05	5/15/06	3	60	195.7	390	3	100%

4. Pollutant Sources

The identification of sources is important to the successful implementation of a TMDL and the control of pollutant loading to a stream. Characterizing watershed sources can provide information on the relative magnitude and influence of each source and its impact on instream water quality conditions. This section discusses the potential sources of fecal coliform to Pederson Hill Creek.

4.1. Point Sources

There are no permitted point sources discharging fecal coliform in the Pederson Creek watershed.

4.2. Nonpoint and Natural Sources

Alaska's 303(d) list identifies septic tanks as the pollutant source causing the bacteria impairment in Pederson Hill Creek. Septic systems have the potential to contribute fecal coliform to receiving waters through surface breakouts and subsurface malfunctions. Failing septic systems located in close proximity to receiving waterbodies are more likely to impact instream conditions.

Residential and commercial buildings within the Pederson Hill drainage are outside of the Juneau sewage treatment system and rely on on-site septic systems. The original 303(d) listing for Pederson Hill Creek in 1990 was due to concerns over areas of failing septic systems and problems with on-site systems continue. The highest fecal coliform levels in available data were measured at stations draining residential and commercial areas served by septic systems (PHC-3, PHC-4a, PHC-6b, PHC-6a, and PHC-5b) and documentation from the WMP and ADEC sampling efforts note several visual observations of septic system leakage or the presence or odor of sewage. In addition, ADEC recently conducted sampling in roadside ditches as well as runoff found on private residential property on Engineers Cutoff Road as part of an ongoing compliance investigation related to failing septic systems (L. Sowa, ADEC, personal communication, December 1, 2006). Results indicated elevated fecal coliform bacteria in both the hillside seep and in the roadside ditches, with values ranging from 63.6 to 1,030 cfu/100 mL. As part of that compliance investigation, a dye test was performed on an expected failing system. The dyed water was evident in a roadside ditch that eventually drains to Pederson Hill Creek. While this system was upgraded, it is an indication of the potentially significant source of bacteria originating with failing septic systems in the Pederson Hill Creek watershed.

The City and Borough of Juneau has plans to extend the public sewer to portions of the Pederson Hill Creek watershed over the next several years (L. Sowa, ADEC, personal communication, December 1, 2006). Phase I of the extension, expected to be completed by the end of 2008, will include eastern portions of the watershed, along Industrial Boulevard and also including Sherwood Lane. Phase II of the project is expected to include portions of Glacier Highway and portions of Engineers Cutoff and Curtis Avenue; however, the timing and specific plans for Phase II are still under development.

ADEC's waterbody assessment (ADEC, 1993) identifies horse farms and pastures in the watershed as another potential source impacting bacteria levels in Pederson Hill Creek. In addition, a horseback trail that runs along the mid-section of the creek could provide occasional localized inputs of bacteria from horse waste. While these sources are not confirmed in available reports or data, they could be contributing to the fecal coliform impairment in the creek. The horse farm noted in the waterbody assessment is located off Curtis Avenue, off a lower tributary to the creek, downstream of any available fecal coliform data. The Swampy Acres horse stable is located on the north side of Glacier Highway, near the intersection with Engineers Cutoff Road. Grant documentation indicates that stations PHC-2a and PHC-2b receive some runoff from the Swampy Acres property while the majority of it flows to the

east, eventually to stations PHC-6a, PHC-5b and ADEC-3. PHC-2 fecal coliform data are relatively low, especially when compared to other stations. All PHC-2 data were less than 40 FC/100 mL and four of the six samples were less than 10 FC/100 mL. Data from PHC-6a, PHC-5b and ADEC-3 are widely variable, including one sample measured at 5,900 FC/100 mL and five of the eight samples measuring less than 20 FC/100 mL. In addition, these stations also represent runoff from the parking lot and office buildings on Sherwood Lane. The available data are not sufficient enough to determine the relative magnitude of the potential sources (residential and commercial inputs or runoff from the horse farms) and their respective influence on instream bacteria levels. However, an informal field visit indicated that the farms are located in close proximity to the stream and animal waste is likely delivered to Pederson Hill Creek in runoff from the properties.

Given the documented problems with improperly constructed or functioning septic systems and the proximity of the horse farms to the creek, it is likely that both failing septic systems and runoff from the horse farms and stables represent the primary sources of bacteria to Pederson Hill Creek. Future monitoring will focus on better characterizing the potential sources of bacteria to the creek and subsequently targeting appropriate control efforts.

5. Analytical Approach

Developing TMDLs requires a combination of technical analysis, practical understanding of important watershed processes, and interpretation of watershed loadings and receiving water responses to those loadings. In identifying the technical approach for development of the fecal coliform TMDL for Pederson Hill Creek, the following core set of principles was identified and applied:

- R ***The TMDLs must be based on scientific analysis and reasonable and acceptable assumptions.*** All major assumptions have been made based on available data and in consultation with appropriate agency staff.
- R ***The TMDLs must use the best available data.*** All available data in the watershed were reviewed and were used in the analysis where possible or appropriate.
- R ***Methods should be clear and as simple as possible to facilitate explanation to stakeholders.*** All methods and major assumptions used in the analysis are described. The TMDL document has been presented in a format accessible by a wide range of audiences, including the public and interested stakeholders.

The analytical approach used to estimate the loading capacity, existing loads, and allocations presented below relies on these principles and provides a TMDL calculation that uses the best available information to represent watershed and instream processes.

Expected sources of fecal coliform to Pederson Hill Creek include failing septic systems in commercial and residential areas and runoff from horse farms in the watershed. A proposed extension of the public sewer system over the next few years is expected to eliminate the use of septic systems in a portion of the watershed. However, additional data are necessary to fully characterize the impact of the horse farms and to understand the magnitude of the expected residential, commercial and agricultural sources in the watershed. Because plans are underway to decrease the impact of septic systems in the watershed and insufficient data are available to characterize inputs from other expected sources, it was not recommended that a time-consuming, detailed approach (e.g., dynamic watershed model) be used for the TMDL. It was assumed that there would be no added benefit from the level of detail gained over using a more simplified approach. Based on this assumption, the load duration approach is used for development of the TMDL for fecal coliform in Pederson Hill Creek. While the approach develops the TMDL for the watershed as a whole, it provides information on critical loading conditions and establishes load reduction targets for various flow conditions. The following sections summarize the approach and its application to Pederson Hill Creek.

5.1. Load Duration Curves

Load reductions for fecal coliform were determined through the use of a load duration curve. The load duration curve approach involves calculating the allowable loadings of a pollutant over the range of flow conditions expected to occur in the impaired stream and include the following steps:

1. A flow duration curve for the impaired segment (or subsegments) is developed using the available flow data. This is done by generating a flow frequency table consisting of ranking all of the observed flows from the least observed flow to the greatest observed flow and plotting those points.
2. The flow curve is translated into a load duration (or TMDL) curve by multiplying each flow by the applicable water quality criterion and a conversion factor and plotting the resulting points.

3. Each pollutant data point from observed data is converted to a daily load by multiplying the concentration by the corresponding average daily flow on the day the sample was taken. The load is then plotted on the TMDL graph.
4. Points plotting above the curve represent deviations from the water quality standard and unallowable loads. Those plotting below the curve represent compliance with standards and represent allowable daily loads.
5. The load duration curve itself can be established as the TMDL. The TMDL would be dynamic and based on flow. Essentially, the loading capacity is the load corresponding to the flow selected along the curve. Alternatively, a static TMDL can be established based on the area beneath the TMDL curve, representing the loading capacity of the stream. The difference between this area and the area representing current loading conditions is the load that must be reduced to meet water quality standards.

The stream flows displayed on a load duration curve may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into 10 groups, which can be further categorized into the following five “hydrologic zones” (Cleland, 2002, 2003):

- High flow zone: flows in the 0 to 10 percentile range, related to flood flows
- Moist zone: flows in the 10 to 40 percentile range, related to wet weather conditions
- Mid-range zone: flows in the 40 to 50 percentile range, median stream flow conditions
- Dry zone: flows in the 60 to 90 percentile range, related to dry weather flows
- Low flow zone: flows in the 90 to 100 percentile range, related to drought conditions

The load duration approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Because the approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

5.2. Stream Flow Estimates

To conduct a load duration curve analysis it is necessary to have a continuous flow record or a dataset of flows covering a broad range of flow conditions during times of water quality sampling in the impaired stream. Unfortunately, Pederson Hill Creek does not meet either of those requirements. In those cases, flow can be estimated for the impaired creek based on nearby USGS gages draining creeks with similar watershed characteristics. Figure 5-1 presents a map of gages in proximity to Pederson Hill Creek. Based on the available periods of record of daily flows, the seven gages listed in Table 5-1 were selected for further evaluation. Based on local knowledge of the watershed characteristics and the overlap of water quality and flow data, Montana Creek (15052800) was initially chosen as the surrogate gage for Pederson Hill Creek. Analysis of the Montana Creek flow record indicated a significant gap in data from October 1987 through October 1999. The gap overlaps with water quality data available for Pederson Hill Creek during 1991, 1992 and 1994. Because data are limited for Pederson Hill Creek, it was necessary to be able to use the datasets from the 1990s in the analysis. Therefore, gages were reevaluated to use as a surrogate for Pederson Hill during times of “missing” data from Montana Creek.

It was believed that Montana Creek and its watershed were similar enough to Pederson Hill Creek that Montana Creek flows were appropriate to represent Pederson Hill. Therefore, flows from surrounding gages were evaluated for similarity to Montana Creek flows to supplement the Montana Creek gage in creating a complete flow record for Pederson Hill Creek. Figures 5-2, 5-3 and 5-4 present Montana Creek daily flows versus matching daily flows in Lemon Creek (15052000), Salmon Creek (15051010), and Gold Creek (15049900), respectively. All of these gages have data available during the years missing from the Montana Creek flow record and corresponding to Pederson Hill Creek monitoring. As shown in the figures, Salmon Creek flows most closely correlate to Montana Creek flows. This is further illustrated

in Figure 5-5, presenting a time-series of overlapping flow data recorded in Montana Creek and Salmon Creek.

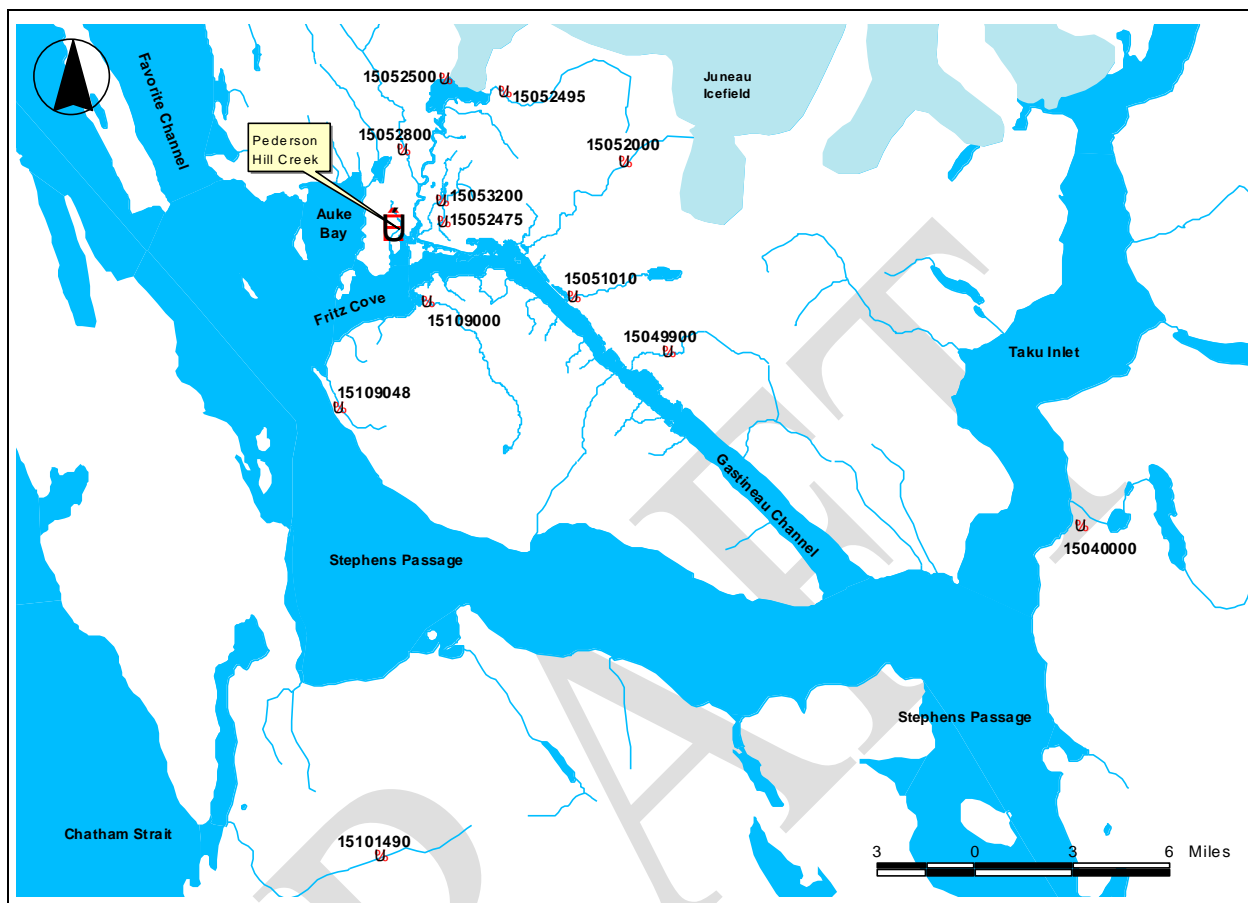


Figure 5-1. Location of USGS gages in proximity to Pederson Hill Creek.

Table 5-1. USGS gages located in proximity to Pederson Hill Creek

Station	Location	Start Date	End Date	Drainage area (mi ²)
15040000	DOROTHY C NR JUNEAU AK	10/1/01	11/4/03	15.2
15049900	GOLD C NR JUNEAU AK	6/1/84	9/30/97	8.41
15051010	SALMON C NR JUNEAU AK	10/1/90	9/30/05	9.69
15052000	LEMON C NR JUNEAU AK	8/1/51	9/30/05	12.3
15052475	JORDAN C BL EGAN DR NR AUKE BAY AK	5/1/97	2/3/06	2.6
15052800	MONTANA C NR AUKE BAY AK	7/1/83	3/14/07	14.1
15101490	GREENS C AT GREENS CREEK MINE NR JUNEAU AK	8/18/89	9/30/05	8.62

Note: All data from the listed gages, and other nearby gages, are “provisional” data—data that have not been reviewed or edited. Provisional data may be changed after review because the stage-discharge relationship may have been affected by backwater from ice or debris such as log jams, algal and aquatic growth in the stream, sediment movement, or malfunction of recording equipment.

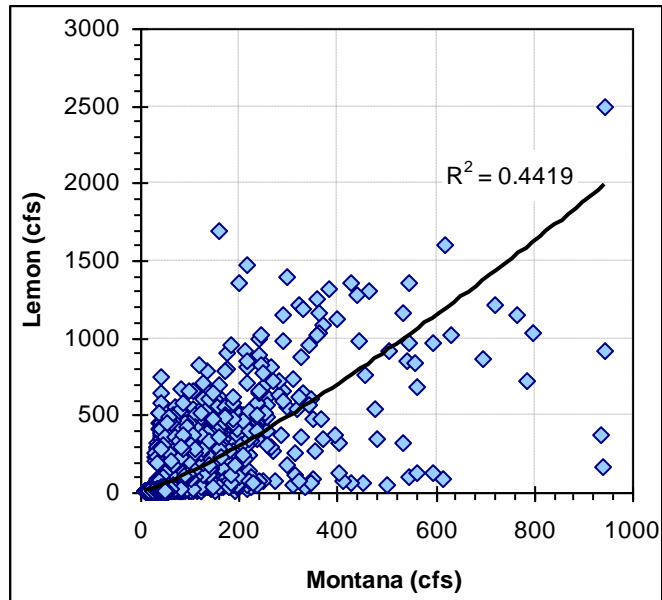


Figure 5-2. Lemon Creek (15052000) flows versus Montana Creek (15052800) flows.

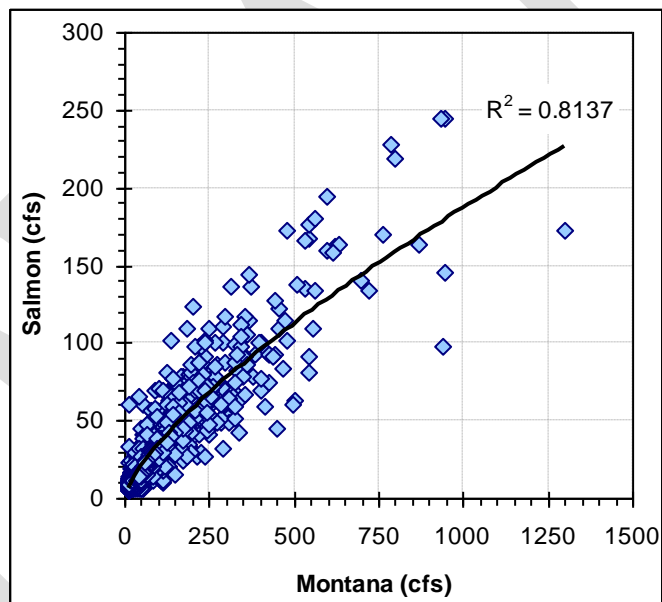


Figure 5-3. Salmon Creek (15051010) flows versus Montana Creek (15052800) flows.

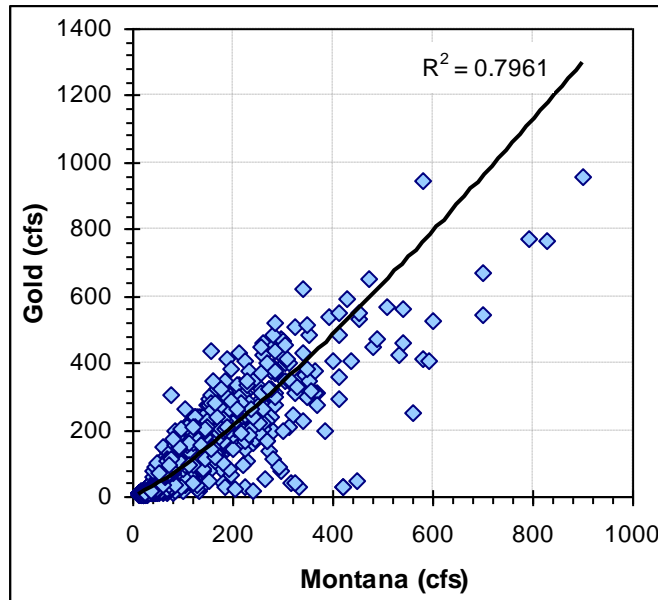


Figure 5-4. Gold Creek (15049900) flows versus Montana Creek (15052800) flows.

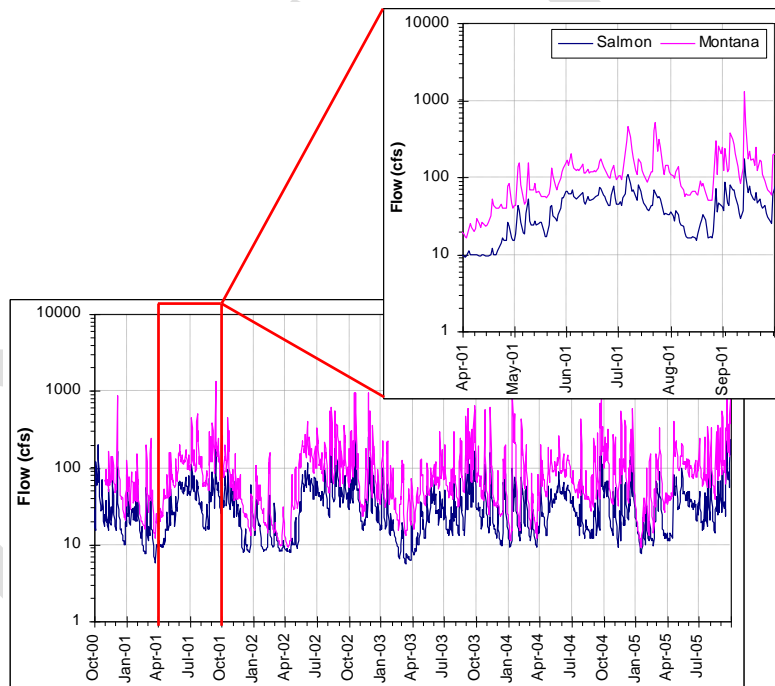


Figure 5-5. Time series of overlapping Montana Creek and Salmon Creek flows.

To create a complete daily flow record for Pederson Hill Creek, Salmon Creek flows were used for January 1991 through October 1999 and Montana Creek flows were used for November 1999 through October 2006. Flows from each gage were adjusted to represent Pederson Hill Creek using ratios of the respective drainage areas. It was assumed that Pederson Hill Creek has a drainage area of 1.6 mi^2 (approximately 1,000 acres).

5.3. Existing Loads and Loading Capacity

The load duration method was used to calculate existing fecal coliform loads and the loading capacity for Pederson Hill Creek. As discussed in Section 5.1, the load duration (or TMDL) curve is developed by multiplying each individual flow in the available flow record by the applicable water quality criterion and a conversion factor and plotting the resulting points. The load duration curve for fecal coliform in Pederson Hill was developed using the not-to-exceed water quality criterion of 40 FC/100 mL and the estimated flow record discussed in Section 5.2, using flows from the years corresponding to available water quality data (1991, 1992, 1994, 2005, and 2006). The curve is presented in Figure 5-6, including daily loads calculated using observed fecal coliform data and the estimated flow for the corresponding sampling date. A summary of the existing and allowable loads is presented in Table 5-2.

Because there are limited data for the creek, existing loads were calculated using all fecal coliform measurements throughout the watershed. Because the watershed is relatively small and stations with available data are clustered within an approximately 0.1-mi² area, it is assumed that combining all data is appropriate for representing the conditions in Pederson Hill Creek.

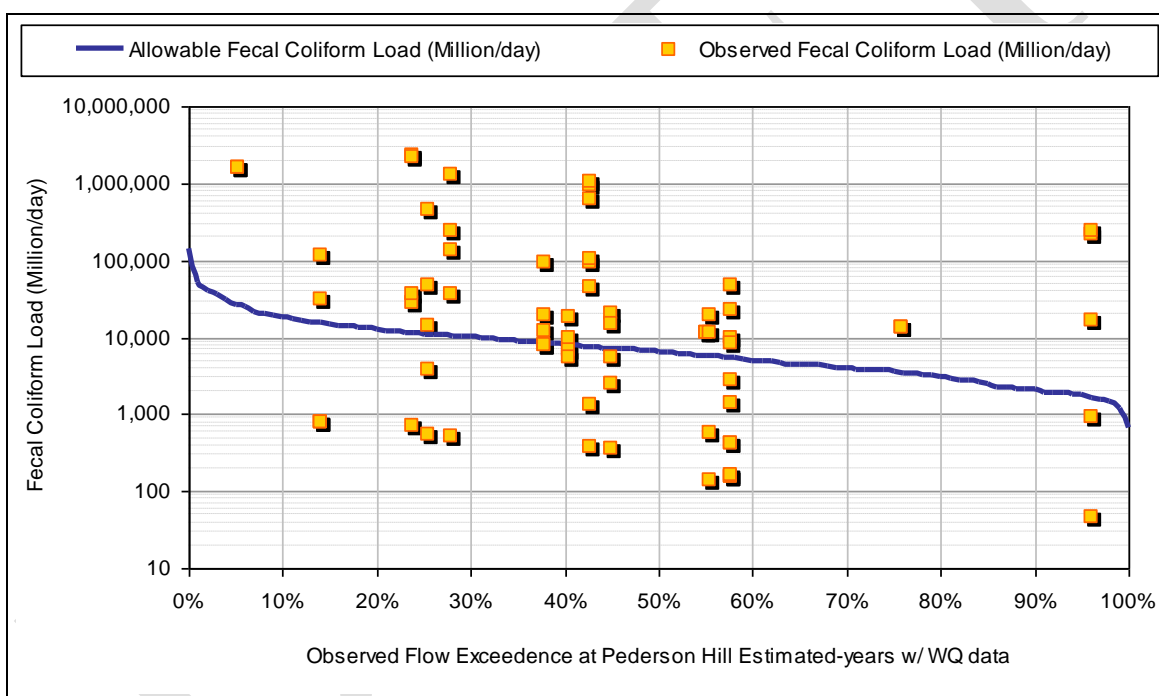


Figure 5-6. Estimated existing fecal coliform loads and loading capacity for Pederson Hill Creek.

Table 5-2. Summary of fecal coliform load duration analysis in Pederson Hill Creek

Flow Exceedance Ranges	68-Sample Distribution	Median Observed Flow (cfs)	Median Allowable Load (Million/day)	Median Observed Load (Million/day)
0-10	2	27.46	26,874	1,599,742
10-40	25	11.23	10,988	27,881
40-60	34	6.60	6,464	8,917
60-90	2	3.63	3,555	13,331
90-100	5	1.82	1,777	16,241

6. TMDL

A TMDL represents the total amount of a pollutant that can be assimilated by a receiving water while still achieving water quality standards. A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background loads. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation

$$\text{TMDL} = \Sigma \text{WLAs} + \Sigma \text{LAs} + \text{MOS}$$

This TMDL will be implemented using adaptive management and will be revised, as necessary, based on future information on sources and instream conditions. Adaptive management is an approach where monitoring and source controls are used to provide more information for future review and revision of a TMDL. This process recognizes that water quality monitoring data and knowledge of watershed dynamics may be insufficient at the time a TMDL is developed, but that the TMDL uses the best information available during its development. An adaptive management strategy seeks to collect additional monitoring data to understand better how systems react to BMPs and reduced pollutant loading into a system. Information from an adaptive management process can then be used to refine a future TMDL, so that the future TMDL and allocations best represent how to improve water quality in a specific watershed.

Table 6-1 presents a summary of the fecal coliform TMDL calculated for Pederson Hill Creek. The TMDL allocations are calculated for the five hydrologic zones identified in Section 5.1. The individual TMDL components are discussed in the following sections.

Table 6-1. TMDL allocations for fecal coliform in Pederson Hill Creek

Fecal Coliform (Million/day)		High Flows	Moist Conditions	Mid-range Flows	Dry Conditions	Low Flows
	TMDL Component	0-10	10-40	40-60	60-90	90-100
	Current Load ¹	1,599,742	27,881	8,917	13,331	16,241
	TMDL= LA+WLA+MOS	26,874	10,988	6,464	3,555	1,777
	LA	24,187	9,889	5,817	3,199	1,599
	WLA	n/a	n/a	n/a	n/a	n/a
	MOS (10%)	2,687	1,099	646	355	178
	Load Reduction to Meet Water Quality Standards (%)	98%	65%	35%	76%	90%

¹Current load represents median existing load for the respective flow zone. TMDL represents median allowable daily load for the respective flow zone.

6.1. Margin of Safety

The MOS accounts for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be implicit (e.g., incorporated into the TMDL analysis through conservative assumptions) or explicit (e.g., expressed in the TMDL as a portion of the loading) or a combination of both. For the Pederson Hill Creek TMDL, the MOS was included explicitly as 10 percent of the loading capacity.

6.2. Load Allocation

Because there are no permitted sources of fecal coliform to Pederson Hill Creek, the entire loading capacity (minus the MOS) is assigned to the load allocation for nonpoint sources.

6.3. Wasteload Allocation

Because there are no permitted point sources discharging fecal coliform to Pederson Hill Creek, the wasteload allocation is established as zero.

6.4. Critical Conditions and Seasonal Variation

USEPA regulations require that TMDLs be developed for critical conditions and consider seasonal variations. The TMDL analysis for Pederson Hill Creek inherently considers both seasonal variation and critical conditions by establishing allocations for various flow conditions. Flow varies by season and is also typically a defining factor in critical conditions (e.g., low flows versus high flows). Therefore, using the load duration approach and establishing flow-variable allowable loads adequately considers critical conditions and seasonal variation.

6.5. Daily Loads

To meet the requirement that TMDLs be expressed as daily loads, the load duration curve established for Pederson Hill Creek and presented in Figure 5-6 can be used to represent dynamic, flow-variable allowable daily loads. The allowable daily load for a given day is determined by the flow measured on the respective day and is equal to the flow multiplied by the water quality criterion of 40 FC/100 mL and an appropriate conversion factor.

7. Implementation

Because the Pederson Hill Creek watershed has a documented history of problems associated with failing septic systems, it is assumed that this source is the primary cause of bacteria impairment in the creek. A proposed extension of the city's public sewer system over the next several years will decrease the use of septic systems in the watershed and continued compliance investigations will work to eliminate failing systems, to the extent possible, thereby reducing the bacteria loads to the creek.

A primary BMP applicable to this watershed is educating area homeowners on the importance of the proper operation and maintenance (O&M) of their onsite septic systems. Site conditions in this area are less than ideal for onsite wastewater treatment and disposal. Steep slopes, wetlands, shallow bedrock and high levels of precipitation are not suited to traditional septic systems. Most of the systems installed in this area are secondary treatment systems (i.e., aerobic treatment units) and rely on mechanical parts that require periodic O&M. Failure to follow the maintenance requirements often results in system failure and the release of improperly treated wastewater. ADEC will continue to respond to citizen complaints about malfunctioning systems and will conduct compliance investigations when necessary. In addition, ADEC will work with the City and Borough of Juneau to educate homeowners on proper O&M.

In addition to failing septic systems, runoff from watershed horse farms is expected to be contributing to the bacteria impairment in Pederson Hill Creek. Future monitoring is recommended to focus on better characterizing expected sources and their impact on in-stream bacteria levels. Based on future data regarding the influence of watershed farms, appropriate control efforts will be identified, as necessary.

Continued water quality monitoring will track progress of water quality improvements and attainment of water quality standards in Pederson Hill Creek. If future data indicate that additional controls are needed, ADEC and the City and Borough of Juneau will work together to identify and implement appropriate BMPs to reduce bacteria loads to the stream. For informational purposes, the following discussion summarizes BMPs commonly used for the reduction of bacteria.

The National Stormwater Best Management Practices database (<http://www.bmpdatabase.org/>) provides access to BMP performance data in a standardized format for over 190 BMP studies conducted over the past fifteen years. The database was developed by the Urban Water Resources Research Council (UWRRC) of American Society of Civil Engineers (ASCE) under a cooperative agreement with the U.S. Environmental Protection Agency.

Some studies on BMP effectiveness have evaluated the ability of certain BMPs to remove fecal coliform and other bacteria. The Center for Watershed Protection has compiled a stormwater treatment database containing information from studies conducted from 1990 to the present. Schueler (2000) provides a summary of the information in the database. The included studies do not provide sufficient fecal coliform data to statistically evaluate the effectiveness of BMPs in removing bacteria from urban runoff, but Schueler (2000) indicates that mean fecal coliform removal rates typically range from 65 to 75 percent from ponds and wetlands and 55 percent for filters. Schueler (2000) and SMRC (2000) also reports that water quality swales (including biofilters and wet and dry swales) consistently exported bacteria. Although it is possible that the bacteria thrive in the warm swale soils, the studies do not account for potential sources of bacteria directly to the swales, such as wildlife and domestic pets. Table 7-1 provides examples of BMP removal efficiencies for bacteria. Because information on BMP efficiency for fecal coliform is limited, information in Table 7-1 should be applied with consideration of local knowledge of the environmental conditions and BMP performance in the Anchorage area.

CWP (1997) discusses the use and effectiveness of BMPs in cold climates. Due to the characteristics such as freezing temperatures and snowmelt events, some BMPs are not appropriate or require modifications for use in cold climates. Table 7-2 provides a summary of the applicability of BMPs to colder climates.

Table 7-1. Fecal coliform removal for various BMPs

BMP Type	Fecal Coliform Bacteria Removal (%)
Detention and Dry Extended Detention Ponds	78
Wet Ponds	70
Shallow Marsh Wetland	76
Submerged Gravel Wetland	78
Filters (excluding vertical sand filters)	37
Infiltration Basins	90
Water Quality Swales	-25
Ditches	5

Adapted from Schueler (2000) and SMRC (2000).

Table 7-2. Applicability of BMPs to cold climate conditions (CWP, 1997)

Type	BMP	Classification	Notes
Ponds	Wet Pond	<input type="checkbox"/>	Can be effective, but needs modifications to prevent freezing of outlet pipes. Limited by reduced treatment volume and biological activity in the permanent pool during ice cover.
	Wet ED Pond	<input type="checkbox"/>	Some modifications to conveyance structures needed. Extended detention storage provides treatment during the winter season.
	Dry ED Pond	<input type="checkbox"/>	Few modifications needed. Although this practice is easily adapted to cold climates, it is not highly recommended overall because of its relatively poor warm season performance.
Wetlands	Shallow Marsh	<input type="checkbox"/>	In climates where significant ice formation occurs, shallow marshes are not effective winter BMPs. Most of the treatment storage is taken up by ice, and the system is bypassed.
	Pond/Wetland System	<input type="checkbox"/>	Pond/Wetland systems can be effective, especially if some ED storage is provided. Modifications for both pond and wetland systems apply to these BMPs. This includes changes in wetland plant selection and planting.
	ED Wetland	<input type="checkbox"/>	See Wet ED Pond. Also needs modifications to wetland plant species.
Infiltration	Porous Pavement	<input type="checkbox"/>	This practice is restricted in cold climates. It cannot be used on any pavement that is sanded, because the pavement will clog.
	Infiltration Trench	<input type="checkbox"/>	Can be effective, but may be restricted by groundwater quality concerns related to infiltrating chlorides. Also, frozen ground conditions may inhibit the infiltration capacity of the ground.

Type	BMP	Classification	Notes
Filtering Systems	Infiltration Basin	<input type="checkbox"/>	See infiltration trench.
	Surface Sand Filter	<input type="checkbox"/>	Frozen ground considerations, combined with frost heave concerns, make this type of system relatively ineffective during the winter season.
	Underground Sand Filter	<input type="checkbox"/>	When placed below the frost line, these systems can function effectively in cold climates.
	Perimeter Sand Filter	<input type="checkbox"/>	See Surface Sand Filter.
	Bioretention	<input type="checkbox"/>	Problems functioning during the winter season because of reduced infiltration. It has some value for snow storage on parking lots, however.
Open Channel Systems	Submerged Gravel Wetlands	<input type="checkbox"/>	Some concerns of bypass during winter flows. Has been used in relatively cold regions with success, but not tested in a wide range of conditions.
	Grassed Channel	<input type="checkbox"/>	Reduced effectiveness in the winter season because of dormant vegetation and reduced infiltration. Valuable for snow storage.
	Dry Swale	<input type="checkbox"/>	Reduced effectiveness in the winter season because of dormant vegetation and reduced infiltration. Very valuable for snow storage and meltwater infiltration.
	Wet Swale	<input type="checkbox"/>	Reduced effectiveness in the winter season because of dormant vegetation. Can be valuable for snow storage.
	Vegetated Filter Strip	<input type="checkbox"/>	See Dry Swale.

ED: Extended Detention

- ☐ Easily applied to cold climates; can be effective during the winter season.
- ☐ Can be used in cold climates with significant modifications; moderately effective during the winter season.
- ☐ Very difficult to use in cold climates. Generally not recommended.

8. Monitoring

Follow-up monitoring for a TMDL is important in tracking the progress of TMDL implementation and subsequent water quality response as well as in evaluating any assumptions made during TMDL development. Monitoring results can be used to support any necessary future TMDL revisions and to track BMP effectiveness. Most importantly, monitoring will track the water quality of Pederson Hill Creek to evaluate future attainment of water quality standards.

ADEC has plans to collect grab samples for fecal coliform analysis at 14 sites in the watershed (Figure 8-1) for two high-flow and two low-flow events during May and June of 2007. In addition, it is recommended that any future monitoring focus on identifying specific areas or sources of concern and on tracking progress of water quality improvement as septic systems are replaced with public sewer. Because much of the available data are distributed over a number of stations and there are very limited data at single stations, a goal of any future monitoring should be to establish station locations that will be sampled during all subsequent sampling efforts in the watershed. Using consistent stations will better allow for evaluation of temporal trends in watershed data.

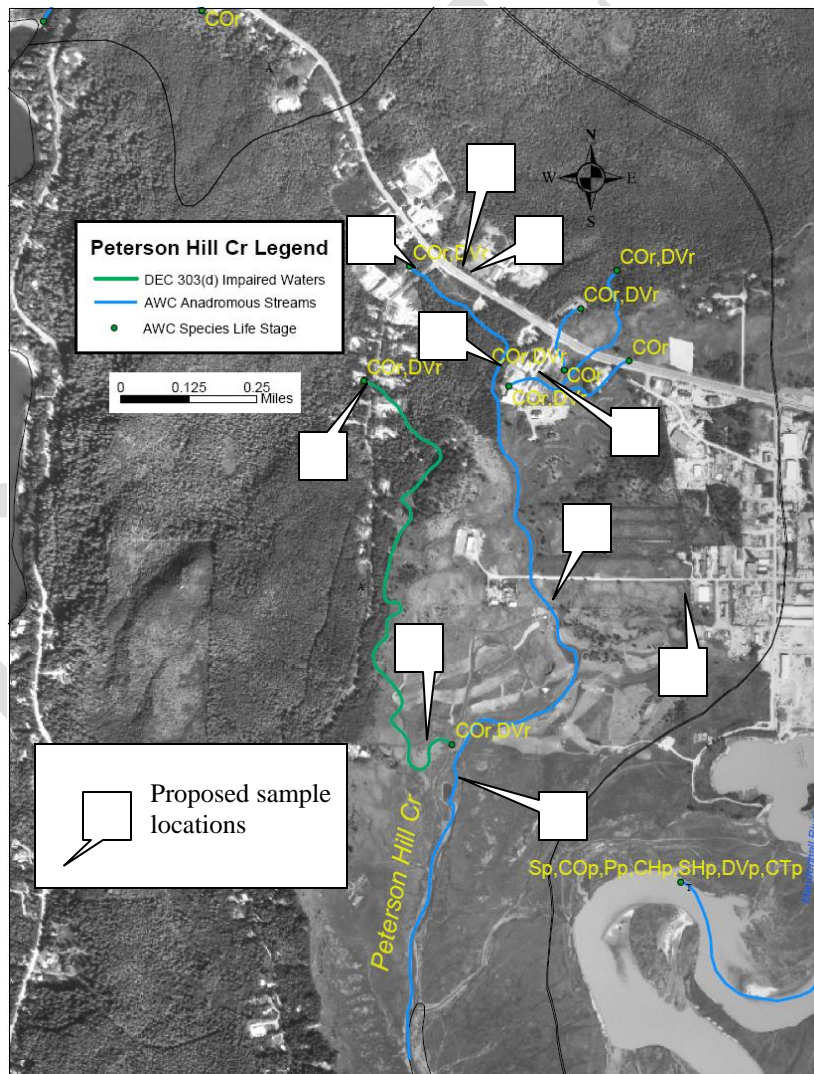


Figure 8-1. Proposed sites for ADEC sampling in April - August 2008.

9. Public Comments

This proposed TMDL is open for public comment from December 9, 2007 to January 14, 2008. People wishing to comment on the proposed TMDL should do so in writing by the close of the public comment period, January 14, 2008. Written comments must be postmarked by the close of the comment period and sent to Joran Freeman, Alaska Department of Environmental Conservation, 410 Willoughby Avenue, Suite 303, P.O. Box 111800, Juneau, AK 99811-1800. Comments may be faxed to ADEC at (907) 465-5274 or e-mailed to joran.freeman@alaska.gov by the close of the public comment period. All comments must include the name, address, and telephone number of the commenter and a concise statement of the comment and the relevant facts upon which it is based.

DRAFT

10. References

ADEC. 1993. *Waterbody Assessment: Pederson Hill Creek*. Alaska Department of Environmental Conservation.

AWSO. 1997. Anchorage Weather Service Office: Anchorage Alaska (PANC/ANC). http://www.uaa.alaska.edu/enri/ascc_web/nwss/anc.html. University of Alaska Anchorage, Anchorage Weather Service Office, Anchorage, AK. Updated July 10, 1997.

Cleland, B. 2002. *TMDL Development from the "Bottom Up." – Part II: Using Duration Curves to Connect the Pieces*. America's Clean Water Foundation, Washington, DC.

Cleland, B. 2003. *TMDL Development from the "Bottom Up" – Part III: Duration Curves and Wet-Weather Assessments*. America's Clean Water Foundation, Washington, DC.

MWP. Undated. *Pederson Creek Watershed Protection and Assessment*. Project Report; ACWA Grant 05-12. Prepared for Alaska Department of Environmental Conservation. Mendenhall Watershed Partnership, Juneau, AK.

Nagorski, S. and E. Hood. 2006. *Watershed Protection and Recovery for Pederson Hill Creek, Juneau, AK*. FY 2006 Final Report, ACWA-06-11. Prepared for Alaska Department of Environmental Conservation. University of Alaska Southeast, Juneau, AK.

WRCC. 2002. *Climate of Alaska*. <http://www.wrcc.dri.edu/narratives/ALASKA.htm>. Western Regional Climate Center.

Appendix: Fecal Coliform Data for Pederson Hill Creek

Site	Date	Qualifier	Result	Agency/source
ADEC-1	5/10/94	<	2	DEC-unknown-8/24/95 memo
ADEC-1	5/16/94	<	2	DEC-unknown-8/24/95 memo
ADEC-1	5/24/94	<	2	DEC-unknown-8/24/95 memo
ADEC-1	5/31/94		2	DEC-unknown-8/24/95 memo
ADEC-2	5/10/94		500	DEC-unknown-8/24/95 memo
ADEC-2	5/16/94		500	DEC-unknown-8/24/95 memo
ADEC-2	5/24/94		50	DEC-unknown-8/24/95 memo
ADEC-2	5/31/94		30	DEC-unknown-8/24/95 memo
ADEC-3	5/10/94		140	DEC-unknown-8/24/95 memo
ADEC-3	5/16/94		7	DEC-unknown-8/24/95 memo
ADEC-3	5/24/94		14	DEC-unknown-8/24/95 memo
ADEC-3	5/31/94		14	DEC-unknown-8/24/95 memo
ADEC-4	5/10/94		5000	DEC-unknown-8/24/95 memo
ADEC-4	5/16/94		5000	DEC-unknown-8/24/95 memo
ADEC-4	5/24/94		170	DEC-unknown-8/24/95 memo
ADEC-4	5/31/94		110	DEC-unknown-8/24/95 memo
ADEC-5	5/10/94		900	DEC-unknown-8/24/95 memo
ADEC-5	5/16/94		240	DEC-unknown-8/24/95 memo
ADEC-5	5/24/94		1600	DEC-unknown-8/24/95 memo
ADEC-5	5/31/94		80	DEC-unknown-8/24/95 memo
ADEC-A	5/16/94		3300	DEC-unknown-8/24/95 memo
ADEC-B	5/16/94		540	DEC-unknown-8/24/95 memo
ADEC-C	5/16/94		5600	DEC-unknown-8/24/95 memo
ADEC-D	5/16/94			DEC-unknown-8/24/95 memo
JSM-1	2/11/91		80	DEC-Juneau Stream Monitoring Project
JSM-1	6/10/91		2400	DEC-Juneau Stream Monitoring Project
JSM-1	9/5/92		150	DEC-Juneau Stream Monitoring Project
PHC-1a	4/18/05		3	MWP FY05 grant
PHC-1a	5/12/05		2	MWP FY05 grant
PHC-1a	6/16/05		33	MWP FY05 grant
PHC-1a	6/24/05		90	MWP FY05 grant
PHC-2a	4/18/05		3	MWP FY05 grant
PHC-2a	5/12/05		2	MWP FY05 grant
PHC-2a	6/9/05		2.5	MWP FY05 grant
PHC-2a	6/16/05		28	MWP FY05 grant
PHC-2a	6/24/05		36.7	MWP FY05 grant
PHC-3a	4/18/05		20	MWP FY05 grant

PHC-3a	5/12/05		82	MWP FY05 grant
PHC-3a	6/9/05		97.5	MWP FY05 grant
PHC-3a	6/16/05		92	MWP FY05 grant
PHC-3a	6/24/05		56.7	MWP FY05 grant
PHC-4a	4/18/05		340	MWP FY05 grant
PHC-4a	5/12/05		300	MWP FY05 grant
PHC-4a	6/9/05		8100	MWP FY05 grant
PHC-4a	6/16/05		50	MWP FY05 grant
PHC-4a	6/24/05		433	MWP FY05 grant
PHC-5a	4/18/05		10	MWP FY05 grant
PHC-5a	5/12/05		2	MWP FY05 grant
PHC-5a	6/24/05		36.7	MWP FY05 grant
PHC-6a	6/9/05		130	MWP FY05 grant
PHC-7a	6/9/05		7600	MWP FY05 grant
PHC-1b	11/5/05	<	1.1	MWP FY06 grant
PHC-1b	2/20/06	<	1.1	MWP FY06 grant
PHC-2b	11/5/05	<	1.1	MWP FY06 grant
PHC-3b	11/5/05		164	MWP FY06 grant
PHC-3b	2/20/06		22	MWP FY06 grant
PHC-3b	5/15/06		82	MWP FY06 grant
PHC-4b	11/5/05		71.1	MWP FY06 grant
PHC-4b	2/20/06		5100	MWP FY06 grant
PHC-4b	5/15/06		4	MWP FY06 grant
PHC-5b	11/5/05	<	1.2	MWP FY06 grant
PHC-5b	2/20/06		5900	MWP FY06 grant
PHC-5b	5/15/06	<	1	MWP FY06 grant
PHC-6b	11/5/05		60	MWP FY06 grant
PHC-6b	2/20/06		390	MWP FY06 grant
PHC-6b	5/15/06		137	MWP FY06 grant